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Geology and Alteration Geochemistry of the Porphyry Cu-Au Deposit at Bajo de la Alumbrera, Argentina

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Abstract

This paper describes the igneous geology, alteration mineralogy, and geochemistry, as well as the ore mineralization history of Bajo de la Alumbrera, a world-class porphyry copper-gold deposit in northwestern Argentina. The deposit occurs in the K-rich calc-alkaline Farallón Negro Volcanic Complex, located 200 km east of the main Andean porphyry copper belt of Chile. The deposit consists of a composite stock of dacitic porphyry intrusions and extends into the surrounding andesitic volcanic rocks. Two of the earliest intrusions, now occupying the center of the intrusive complex, show intense hydrothermal alteration and mineralization. These two porphyries host the highest ore grades and were subsequently intruded by several weakly mineralized or barren porphyries.

Intense quartz-magnetite (±K feldspar) alteration pervades the first mineralized porphyry, whereas similar, but lower intensity alteration affected the second. Laterally, this alteration grades into potassic alteration (secondary K feldspar and biotite), which affects all porphyries except the latest dikes. Andesitic wall rocks within a hundred meters of the intrusions are dominated by dark hydrothermal biotite. An outer halo of propylitic alteration (epidote-chlorite-albite-calcite) extends up to 1 km into the andesites. Feldspar-destructive alteration (sericite + pyrite ± clay minerals ± gypsum) overprints the potassic and propylitic alteration in the volcanic rocks and all porphyries. The alteration is locally controlled by faults and late fractures and developed most pervasively upon the outer part of the potassic zone and toward the transition to propylitic alteration in the upper part of the deposit. Mass-balance calculations show small positive changes in net volume for the potassic alteration and minor volume decreases for the chlorite-epidote and feldspar-destructive alteration. The intensely quartz-magnetite veined sample of quartz-magnetite alteration indicates a total volume increase of 350 percent.

Copper and gold are intimately associated at all scales. They occur as composite gold sulfide grains (chalcopyrite, rarely bornite), show a close correlation of ore grades in sample assays, and have a closely overlapping distribution on the mine scale. A well-developed ore shell coincides with potassic alteration and partly with the distribution of intense quartz ± magnetite veins, even though the bulk of the ore minerals now occupy texturally late positions in vugs and fractures. A barren zone with intense quartz-magnetite ± potassic alteration and veins, but little or no sulfides, is interpreted as the focus of upflow of high-temperature ore fluids, prior to ore mineral saturation and coprecipitation of copper sulfides and gold in the ore shell.